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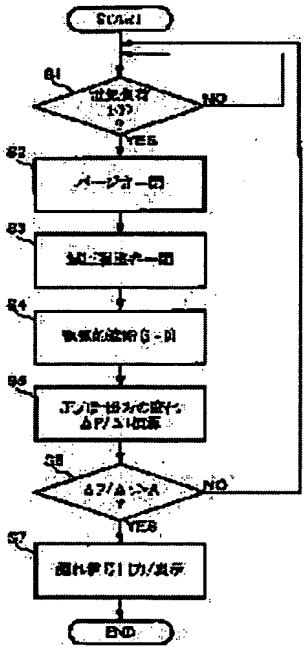
(71)Applicant : NISSAN MOTOR CO LTD
(72)Inventor : SAKAI MASANOBU
UEHARA TETSUYA
TORII SHUJI

(54) GAS LEAKAGE DETECTING METHOD AND DEVICE FOR FUEL CELL SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an inexpensive detecting device for detecting the leakage of fuel gas from a fuel gas circulating supply system during operating a vehicular fuel cell system.

SOLUTION: When a value for an output current i in a fuel cell is smaller than a threshold during regenerating decelerating energy (S1), the output current i is shut off by an output current circuit breaker to stop the generation of a fuel cell (S4) and, in turn, a purge valve for discharging water together with the fuel gas from a circulation system and a pressure reducing control valve for controlling the supply of the fuel gas from a fuel supply source are forcibly closed (S2, S3). At this point pressure in a closed space of the fuel gas circulating supply system is detected by a pressure gage, and when the detection result of the pressure gage shows pressure drop at a reference speed or faster, the leakage of the fuel gas is determined (S5-S7).



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CLAIMS

[Claim(s)]
[Claim 1] The gas leakage detection approach of the fuel cell system characterized by detecting the fuel gas leakage in said closed space based on the pressure condition in the closed space of the fuel gas circulation supply system which intercepts the output current of said fuel cell and contains said fuel cell at this time when the electric load of a fuel cell is smaller than a threshold.
[Claim 2] The gas leakage detection approach of the fuel cell system according to claim 1 characterized by intercepting compulsorily the supply of the fuel gas from a fuel source to said closed space, and detecting fuel gas leakage based on the pressure drawdown rate in this closed space.
[Claim 3] The gas leakage detection approach of the fuel cell system according to claim 1 characterized by detecting fuel gas leakage based on the pressure loss section order differential pressure in said closed space.
[Claim 4] In the fuel cell system constituted including a fuel cell, a fuel source, and a fuel gas circulation supply system An output current cutoff means to intercept the output current of said fuel cell, and a pressure condition detection means to detect the pressure condition in the closed space of the fuel gas circulation supply system containing said fuel cell, When the electric load of a fuel cell was smaller than the threshold and it is distinguished with an electric load distinction means by which the electric load of said fuel cell distinguishes a condition smaller than a threshold, and this electric load distinction means When cutoff of the output current is performed by the cutoff control means which intercepts the output current of a fuel cell with said output current cutoff means, and this cutoff control means Gas leakage detection equipment of the fuel cell system characterized by being constituted including a fuel gas leakage decision means to judge the existence of fuel gas leakage from said closed space, based on the pressure condition detected with said pressure condition detection means.
[Claim 5] In the fuel cell system constituted including a fuel cell, a fuel source, and a fuel gas circulation supply system An output current cutoff means to intercept the output current of said fuel cell, and a source-of-supply cutoff means to intercept compulsorily supply of the fuel gas from the fuel source to said fuel gas circulation supply system, A pressure detection means to detect the pressure in the closed space of the fuel gas circulation supply system containing said fuel cell, When the electric load of a fuel cell was smaller than the threshold and it is distinguished with an electric load distinction means by which the electric load of said fuel cell distinguishes a condition smaller than a threshold, and this electric load distinction means While intercepting the output current of a fuel cell with said output current cutoff means When cutoff of the output current and supply of the fuel gas from said fuel source are compulsorily intercepted by the cutoff control means which makes supply of the fuel gas from a fuel source intercept compulsorily with said source-of-supply cutoff means, and this cutoff control means Gas leakage detection equipment of the fuel cell system characterized by being constituted including a fuel gas leakage decision means to judge the existence of fuel gas leakage from said closed space, based on the fall velocity of the pressure detected with said pressure detection means.
[Claim 6] The gas-leakage detection equipment of the fuel cell system according to claim 5 by which it constitutes so that said pressure detection means may detect the pressure of each of two or more of said

closed space, and said fuel-gas leakage decision means is characterized by to judge the existence of fuel-gas leakage, and the generating part of fuel-gas leakage based on the pressure drawdown rate for two or more of said closed space of every while having a closed-space division means intercept the closed space of the fuel-gas circulation supply system containing said fuel cell to two or more closed space.
[Claim 7] Gas leakage detection equipment of the fuel cell system according to claim 5 by which said pressure detection means detects the pressure between the pressure loss sections in said closed space to each by two or more places, and said fuel gas leakage decision means is characterized by judging the existence of fuel gas leakage, and the generating part of fuel gas leakage based on the pressure drawdown rate which can be set at least to each detecting element.
[Claim 8] Gas leakage detection equipment of the fuel cell system according to claim 7 characterized by judging generating of the fuel gas leakage by about the detecting element which showed the biggest fall velocity when the biggest pressure drawdown rate of the pressure drawdown rates which said fuel gas leakage decision means can set at least to said each detecting element is larger than a threshold.
[Claim 9] In the fuel cell system constituted including a fuel cell, a fuel source, and a fuel gas circulation supply system A differential pressure detection means to detect the at least one pressure loss section order differential pressure in the closed space of an output current cutoff means to intercept the output current of said fuel cell, and the fuel gas circulation supply system containing said fuel cell, When the electric load of a fuel cell was smaller than the threshold and it is distinguished with an electric load distinction means by which the electric load of said fuel cell distinguishes a condition smaller than a threshold, and this electric load distinction means When cutoff of the output current is performed by the cutoff control means which intercepts the output current of a fuel cell with said output current cutoff means, and this cutoff control means Gas leakage detection equipment of the fuel cell system characterized by being constituted including a fuel gas leakage decision means to judge the existence of fuel gas leakage from said closed space, based on the differential pressure detected with said differential pressure detection means.
[Claim 10] Gas-leakage detection equipment of the fuel cell system according to claim 9 characterized by to judge the generating part of fuel-gas leakage based on the direction of the differential pressure in each adjoining detecting element while said differential pressure detection means detects to each two or more pressure loss sections order differential pressure which can be set in said closed space, and it judges generating of fuel gas leakage, when said order differential pressure of said fuel gas leakage decision means is larger than a threshold.
[Claim 11] The gas-leakage detection equipment of the fuel cell system of any one publication of claim 4-10 characterized by to establish a purge cutoff means intercept the purge by said purge means compulsorily, and make said closed space form when said fuel cell system is constituted including a purge means control the purge from the circulatory system of a fuel-gas circulation supply system and the fuel-gas leakage by said fuel-gas leakage decision means is made to judge.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the approach and equipment which detect the leakage of fuel gas inside a fuel cell system in detail about the gas leakage detection approach and equipment of a fuel cell system.
[0002]
[Description of the Prior Art] Conventionally, in a fuel cell system, there was an approach indicated by JP,11-224681,A and JP,8-329965,A as an approach of detecting the leakage of hydrogen content fuel gas. The approach indicated by said JP,11-224681,A judges leakage of fuel gas by computing the amount of the fuel gas used in a fuel cell, computing the fuel gas pressure in a fuel chemical cylinder from this amount of the fuel gas used based on the output current value of a fuel cell, and comparing this calculation pressure with the pressure value actually detected by the pressure sensor.
[0003] Moreover, the approach indicated by JP,8-329965,A prepares a valve in the upper section and the downstream of a fuel cell respectively, encloses fuel gas by closing said valve before a generating mode, detects the pressure variation with a pressure detection means, and he is trying to detect leakage of fuel gas based on the fall of charged pressure.
[0004]
[Problem(s) to be Solved by the Invention] However, by the approach indicated by JP,11-224681,A, there was a problem that consumption of the fuel gas by purge control might be incorrect-detected as leakage. If it becomes so that the steam contained in the humidification hydrogen content fuel gas supplied to a fuel cell serves as water around a fuel electrode and water is [system / fuel cell] full of a discharge path, the flooding phenomenon of resulting in the loss of power of a fuel cell will arise.
[0005] When fullness of water is judged as a cure of the above-mentioned flooding phenomenon based on the loss of power of a fuel cell, he is trying to make water purge using fuel gas. Here, since the fuel gas used for the purge hardly contributes to the output of a fuel cell, when the fuel gas used for the purge will be computed as a part for leakage and you are going to make it detect leakage with high precision, the problem that generating of leakage is incorrect-detected at the time of purge activation will arise.
[0006] Moreover, although the approach indicated by JP,8-329965,A is the cheap detection approach since it can judge the existence of fuel gas leakage under supervising the value of a pressure gage, since it was an approach of detecting leakage before starting, leakage generating after a start up had the fault of not being detected until it starts again. There is much possibility that leakage, such as carrying out heat deformation greatly in response to the fact that a mechanical vibration and the mechanical input of an impact which are produced with transit, and a still more nearly thermal change, will arise in the fuel cell system for cars especially during transit overwhelmingly.
[0007] Therefore, by the leakage detection approach that it is detectable that it is only before starting like the conventional example, the problem that required detectability ability is not securable to the fuel cell system for cars will arise. This invention is made in view of the above-mentioned trouble, the leakage of fuel gas can be detected also in operation, and it is in ** offering the cheap gas leakage

detection approach and the equipment of a fuel cell system.
[0008]
[Means for Solving the Problem] Therefore, with the detection approach and equipment concerning invention of claim 1 and four publications, when the electric load of a fuel cell was smaller than a threshold, the output current of a fuel cell was intercepted, and based on the pressure condition in the closed space of the fuel gas circulation supply system containing the fuel cell at this time, it considered as the configuration which detects the fuel gas leakage in said closed space.
[0009] According to the above-mentioned configuration, the electric load of a fuel cell is smaller than a threshold, and if it will be in the condition that a generation of electrical energy of a fuel cell can be stopped, a generation of electrical energy of a fuel cell will be stopped by intercepting the output current of a fuel cell. If a generation of electrical energy is stopped, it will be in the condition that fuel gas is not consumed with a fuel cell, and since the pressure condition in the closed space of the fuel gas circulation supply system containing a fuel cell comes to be influenced by only leakage, it will detect the existence of fuel gas leakage from a pressure condition.
[0010] With the detection approach and equipment concerning invention of claim 2 and five publications, when the electric load of a fuel cell was smaller than a threshold, while intercepting the output current of a fuel cell, the supply of the fuel gas from a fuel source to said closed space was intercepted compulsorily, and it considered as the configuration which detects fuel gas leakage based on the pressure drawdown rate in a closed space at this time. In the closed space where supply of the fuel gas from a fuel source is intercepted according to the above-mentioned configuration, if fuel gas flows out outside by leakage, since the pressure in a closed space will decline rapidly compared with the time of there being no leakage, generating of leakage will be detected based on whether a pressure drawdown rate is large to extent which shows generating of leakage.
[0011] With the detection approach and equipment concerning invention of claim 3 and nine publications, the pressure loss section order differential pressure in said closed space was detected, and it considered as the configuration which detects fuel gas leakage based on order [this] differential pressure. since according to the above-mentioned configuration the flow of fuel gas will occur in a closed space and differential pressure will arise before and after the pressure loss section by this flow, when the leakage from a closed space occurs -- pressure loss section order differential pressure -- being based -- the generating flow of fuel gas -- detecting -- with -- **** -- the existence of fuel gas leakage is detected.
[0012] In the configuration which detects fuel gas leakage with the detection equipment concerning invention according to claim 6 based on the pressure drawdown rate in said closed space When making leakage detect by cutoff of the output current, the closed space of the fuel gas circulation supply system containing a fuel cell is intercepted to two or more closed space. And it constituted so that the pressure of each of two or more of these closed space might be detected, and based on the pressure drawdown rate for said two or more closed space of every, it considered as the configuration which judges the existence of fuel gas leakage, and the generating part of fuel gas leakage.
[0013] According to the above-mentioned configuration, the closed space where supply of the fuel gas from a fuel source is intercepted is intercepted to plurality, and the generating part of fuel gas leakage is pinpointed in either of said two or more closed space by making a pressure detect for these two or more closed space of every. With the detection equipment concerning invention according to claim 7, it set in the configuration which detects fuel gas leakage based on the pressure drawdown rate in said closed space, the pressure between the pressure loss sections in said closed space was detected to each by two or more places, and it considered as the configuration which judges the existence of fuel gas leakage, and the generating part of fuel gas leakage based on the pressure drawdown rate which can be set at least to each detecting element.
[0014] According to the above-mentioned configuration, the multi-statement of the false closed space bordering on the pressure loss section is carried out, and the generating part of fuel gas leakage is pinpointed in either of said false closed space from the pressure drawdown rate for this every false closed space. With the detection equipment concerning invention according to claim 8, in the

configuration of claim 7, when the biggest pressure drawdown rate of the pressure drawdown rates which can be set at least to each detecting element was larger than a threshold, it considered as the configuration which judges generating of the fuel gas leakage by about the detecting element which showed the biggest fall velocity.

[0015] According to the above-mentioned configuration, although the fuel gas leakage by one place will affect other detection pressure force through the pressure loss section, since the pressure drawdown in the generating part of fuel gas leakage becomes the largest, at least the detecting element which showed the biggest fall velocity is specified as a generating part of fuel gas leakage. In the configuration which detects fuel gas leakage with the detection equipment concerning invention according to claim 10 based on the pressure loss section order differential pressure in said closed space When said order differential pressure was larger than a threshold, while two or more pressure loss sections order differential pressure in said closed space was detected to each, and judging generating of fuel gas leakage, it considered as the configuration which judges the generating part of fuel gas leakage based on the direction of the differential pressure in each adjoining detecting element.

[0016] According to the above-mentioned configuration, from the direction of pressure loss section order differential pressure, the flow direction of fuel gas can be pinpointed and the generating part of fuel gas leakage is pinpointed based on this. With the detection equipment concerning invention according to claim 11, when making the existence of fuel gas leakage judge, it considered as the configuration in which intercept compulsorily the purge from the circulatory system by the purge means, and said closed space is made to form.

[0017] According to the above-mentioned configuration, a purge is compulsorily intercepted so that leakage detection can be made to perform a fuel gas circulation supply system as a closed space.

[0018]

[Effect of the Invention] According to invention of claim 1 and four publications, when the electric load of a fuel cell is smaller than a threshold, the output current of a fuel cell is intercepted. Since the closed space where fuel gas is not consumed is made to form, for example in a vehicle use fuel cell system When regeneration of moderation energy is performed, the output current of a fuel cell is small, or when there is no need for the output current, it is effective in the ability to make fuel leakage detect and detect fuel gas leakage with a comparatively cheap pressure gage in the middle of operation.

[0019] According to invention of claim 2 and five publications, since leakage is made to detect based on the pressure drawdown in the closed space where supply of the fuel gas from a fuel source is intercepted, there is effectiveness that fuel gas leakage is detectable in the middle of operation with a simple configuration. ** is also effective in generating of fuel gas leakage being detectable with high precision, without being influenced by the absolute pressure in a closed space since the flow of the fuel gas produced by fuel gas leakage is made to detect based on the pressure loss section order differential pressure in a closed space according to invention of claim 3 and nine publications.

[0020] According to invention according to claim 6, based on the pressure drawdown for every closed space intercepted by plurality, it is effective in the ability to pinpoint the generating part of fuel gas leakage with a sufficient precision. According to invention according to claim 7, without classifying a fuel gas circulation supply system into plurality using a valve etc., the generating part of fuel gas leakage can be pinpointed and there is effectiveness of the ability to make a leakage part pinpoint with a simple configuration.

[0021] According to invention according to claim 8, even if the effect of fuel gas leakage affects at least other pressure detecting elements through the pressure loss section, it is effective in the ability to pinpoint the generating part of fuel gas leakage with a sufficient precision from a pressure drawdown rate. According to invention according to claim 10, it is effective in the ability to pinpoint the flow direction of the fuel gas accompanying fuel gas leakage, and pinpoint the generating part of fuel gas leakage with a sufficient precision from pressure loss section order differential pressure.

[0022] According to invention according to claim 11, a closed space required for detection of fuel gas leakage is made to form certainly, and when the electric load of a fuel cell is smaller than a threshold, there is effectiveness of the ability to make detection of fuel gas leakage ensure.

[0023]
[Embodiment of the Invention] The gestalt of operation of this invention is explained based on drawing below. Drawing 1 is drawing showing the vehicle use fuel cell system in the 1st operation gestalt. In this drawing 1 the fuel gas from the source 1 (fuel source) of hydrogen gas supply The fuel gas supply line 2, the reduced pressure regulator valve 3, the fuel gas supply line 4, an ejector 5, and the fuel gas supply line 6 are minded. The fuel gas which was introduced into the fuel electrode (illustration abbreviation) of a fuel cell 10, and was not consumed with a fuel cell 10 flows back to the fuel gas supply line 6 with said ejector 5 through fuel gas discharge Rhine 11 and the fuel gas circulation line 12.
[0024] A fuel gas circulation supply system is constituted by the above-mentioned fuel gas supply line 2, the reduced pressure regulator valve 3 (source-of-supply cutoff means), the fuel gas supply line 4, an ejector 5, the fuel gas supply line 6, fuel gas discharge Rhine 11, and the fuel gas circulation line 12. The purge line 14 where a purge valve 13 is infixed is connected to said fuel gas discharge Rhine 11.
[0025] A purge means is constituted by the above-mentioned purge valve 13 and the purge line 14. When making water collected on fuel gas discharge Rhine 11 discharge with fuel gas, open control of said purge valve 13 is carried out. On the other hand, to the air pole (illustration abbreviation) of a fuel cell 10, the oxidation gas (air) from the source 20 of oxidation gas supply is supplied through gas supply Rhine 21, and the oxidation gas which was not consumed with a fuel cell 10 is discharged through discharge Rhine 22.
[0026] Moreover, the ammeter 31 which detects the output current i, and the output current breaker 30 (output current cutoff means) which intercepts said output current i are infixed in the output wiring 32 which outputs the output current i of said fuel cell 10. Furthermore, the pressure gage 7 (a pressure condition detection means, pressure detection means) which detects the pressure in said fuel gas supply line 6 is formed.
[0027] The signal processor 40 into which the detection output of said ammeter 31 and a manometer 7 is inputted has the function to make the reduced pressure regulator valve 3 intercept compulsorily while controlling the switching action of said purge valve 13 and the output current breaker 30. In the above-mentioned configuration, the fuel gas flow Q 0 is supplied from the source 1 of hydrogen gas supply, and the flow Q 1 (=Q0+Q2) which added the reflux quantity of gas flow Q2 with the ejector 5 is led to the fuel electrode of a fuel cell 10.
[0028] In a fuel cell 10, the flow rate of deltaQ corresponding to the output current i is consumed, the fuel gas Q2 which remained circulates, and it flows back to the fuel gas supply line 6. That is, the fuel gas flow rate supplied to the fuel electrode of a fuel cell 10 has the relation of deltaQ=Q1-Q2=Q0, and said reduced pressure regulator valve 3 supplies the fuel gas corresponding to the consumption fuel quantity (pressure drop of a fuel gas circulation supply line) in a fuel cell 10.
[0029] The electric load i demanded by the car, i.e., the output current, here In having regenerative-braking equipment which is the value which may be changed very sharply, for example, transforms car inertia energy into electrical energy at the time of car braking (at the time of moderation) Since electrical energy may be supplied by regenerative braking, the output current i from a fuel cell 10 becomes needlessness or a very small value, and at this time, the reduced pressure regulator valve 3 will intercept the flow of fuel gas, or will extract the amount of supply Q0 minutely.
[0030] And since the conditions which make the output current zero (or minute value) will be canceled if regenerative braking is completed, the fuel gas consumption flow rate corresponding to the demand current i corresponding to car electric load is reproduced, and the fuel supply flow rate Q0 also comes to flow out. Thus, in the fuel cell system for cars, a generation of electrical energy of a fuel cell 10 is not always required, and while the condition that a generation of electrical energy of a fuel cell 10 can be stopped operates, it generates.
[0031] In the condition that a generation of electrical energy of a fuel cell 10 is suspended, since fuel gas is not consumed with a fuel cell 10, if it is in the condition which the purge valve 13 has closed and forms a closed space, fuel gas will be shut up in a closed space and big pressure variation will not be generated. Here, when supply of the fuel gas from the source 1 of hydrogen gas supply was intercepted and the leakage of the fuel gas from a closed space occurs, the pressure of said closed space will descend

and generating of fuel gas leakage can be presumed based on the starting pressure drawdown.
[0032] Then, said signal processor 40 detects the existence of fuel gas leakage with a procedure as shown in the flow chart of drawing 2 . In addition, said signal processor 40 is equipped with the function as an electric load distinction means, a cutoff control means, a fuel gas leakage decision means, and a purge cutoff means as shown in the flow chart of drawing 2 .
[0033] First, at step S1, it distinguishes whether the output current i (electric load) is smaller than a threshold i0. And when smaller than a threshold i0, the output current i (electric load) progresses to step S2, and holds a purge valve 13 to a closed state compulsorily, and it is made to make the reduced pressure regulator valve 3 hold to a closed state compulsorily at the following step S3.
[0034] In addition, it is good also as a configuration which a latching valve is prepared [configuration] in the upstream or the downstream of the reduced pressure regulator valve 3, and makes supply of the fuel gas from the source 1 of hydrogen gas supply intercept compulsorily. Furthermore, in step S4, with said output current breaker 30, the output of the output current i is intercepted and a generation of electrical energy (consumption of fuel gas) of a fuel cell 10 is stopped. While the closed space which contains the fuel cell 10 with which supply of the fuel gas from the source 1 of hydrogen gas supply is intercepted by the above-mentioned processing is formed mechanically, when consumption of the fuel gas in a fuel cell 10 is set to 0 and there is no leakage of the fuel gas from said closed space, change with the big pressure detected with said pressure gage 7 is not shown.
[0035] At step S5, variation delta P/delta t of per unit time amount deltat of the detection pressure force P by said pressure gage 7 which shows the pressure drawdown rate in said closed space is calculated. In addition, said variation delta P/delta t shall be computed by the value of plus to reduction change of a pressure P. And at step S6, it distinguishes whether said variation delta P/delta t is larger than a threshold A.
[0036] When said variation delta P/delta t is judged that the threshold A was exceeded and the reduction rate of a pressure P is over a reference value, by the leakage of the fuel gas from a closed space, it is judged as what is carrying out pressure drawdown the rate more than predetermined, it progresses to step S7, and the output and leak-detection display output of a leak-detection signal are performed. Said leak-detection display output is a control signal which performs lighting of the alarm lamp prepared near the driver's seat of a car etc.
[0037] At the fuel gas leak detection by the above-mentioned operation gestalt, since the comparatively cheap pressure gage 7 is used while generating of fuel gas leakage is detectable with a sufficient response, since the existence of fuel gas leakage can be made to judge whenever the output current i (electric load) becomes smaller than a threshold i0 during operation (every [for example,] moderation operation), leak-detection equipment can consist of low cost. By the way, with the above-mentioned operation gestalt, since it is the configuration of forming one pressure gage 7 to the closed space of the fuel gas circulation supply system which comes to contain the reduced pressure regulator valve 3, the fuel gas supply line 4, an ejector 5, the fuel gas supply line 6, a fuel cell 10, fuel gas discharge Rhine 11, and the fuel gas circulation line 12, although it is detectable that fuel gas leakage has occurred in either of the closed space, a leakage generating part cannot be limited.
[0038] Then, as shown in the 2nd operation gestalt shown in drawing 3 , while forming the latching valves 8 and 15 (closed-space division means) which carry out division cutoff of the closed space of a fuel gas circulation supply system in two more closed space As pressure gages 7 and 9 are formed for every closed space intercepted by these latching valves 8 and 15, which pressure detection value can pinpoint the part of fuel gas leakage in either of said two closed space by whether the pressure drawdown rate more than predetermined is shown.
[0039] While infixing the 1st latching valve 8 in the middle of the fuel gas supply line 6 and specifically infixing the 2nd latching valve 15 in the middle of fuel gas discharge Rhine 11, a pressure gage 7 is formed so that the pressure in the fuel gas supply line 6 between the 1st latching valve 8 and an ejector 5 may be detected, and the pressure gage 9 is provided so that the pressure in fuel gas discharge Rhine 11 between the 2nd latching valve 15 and a fuel cell 10 may be detected.
[0040] And with the 2nd operation gestalt, as it is shown in the flow chart of drawing 4 , a leak detection

is performed. In the flow chart of drawing 4 , like said step S1 - step S3, on condition that the output current i of a fuel cell 10 is smaller than a threshold i0, at step S11 - step S13, processing which holds compulsorily a purge valve 13 and the reduced pressure regulator valve 3 to a closed state is performed.
[0041] Furthermore, division cutoff of the closed space of a fuel gas circulation supply system is carried out two by closing said latching valves 8 and 15 at the following step S14. And at step S15, with said output current breaker 30, the output of the output current i is intercepted and a generation of electrical energy (consumption of fuel gas) of a fuel cell 10 is stopped. Two closed space which does not show the fall with a pressure rapid when there is no leakage of fuel gas by the above-mentioned processing is formed.
[0042] In step S16, based on the detection pressure force P1 of a pressure gage 7, Variation delta P1/delta t (pressure drop rate) is calculated, and Variation delta P2/delta t (pressure drop rate) is calculated at step S17 based on the detection pressure force P2 of a pressure gage 9. step S18 -- step S -- it distinguishes whether variation delta P/delta t which chose the larger one of the variation deltaP1 computed by 16 and 17/delta P2 [delta t and]/the delta t (the one where fall velocity is quicker), and was chosen at step S18 in step S19 is larger than a threshold A.
[0043] And when larger than a threshold A, while variation delta P/delta t progresses to step S20 and performs the output and leak-detection display output of a leak-detection signal, a fuel gas leakage generating part is made to memorize by memorizing the pressure gages 7 and 9 which progressed to step S21, for example, detected leakage generating. Even if leakage occurs temporarily, the leakage section is closed after that and an alarm is no longer outputted by memorizing a leakage generating part, the hysteresis and the leakage generating part of leakage can be known later.
[0044] In addition, storage of a leakage generating part may use the memory in said signal processor 40 etc., and may be stored in the storage formed according to the individual. With this operation gestalt, since division cutoff of the closed space was carried out by latching valves 8 and 15 two for example, when the value to which the fall velocity of the detection pressure force of a pressure gage 7 is larger than another side, and exceeds a threshold A is shown Fuel gas leakage will have occurred in either of the closed space from a latching valve 15 to a latching valve 8 via the fuel gas circulation line 12 and an ejector 5. On the contrary, when the value to which the fall velocity of the detection pressure force of a pressure gage 9 is larger than another side, and exceeds a threshold A is shown, fuel gas leakage will have occurred in either of the closed space from a latching valve 8 to a latching valve 15 via a fuel cell 10 and fuel gas discharge Rhine 11.
[0045] In addition, although considered as the configuration which can pinpoint a leakage generating part in either of two closed space by carrying out division cutoff of the closed space two, and forming a pressure gage in each with the above-mentioned operation gestalt, if the number of the closed space which carries out division cutoff is set or more to three and each is equipped with a pressure gage, a fuel gas leakage part can be pinpointed more finely. However, what is necessary is for a scale, piping structure, etc. of a fuel gas distribution system just to determine a required number practically.
[0046] Moreover, although are considered as the configuration which forms two closed space which intercepted a closed space mechanically and became independent mutually by latching valves 8 and 15 with the above-mentioned 2nd operation gestalt, and the ejector 5 infixed in a fuel gas circulation supply line and a fuel cell 10 constitute the pressure loss section and the pressure drawdown in the part of fuel leakage influences all the closed space, the effect degree is restricted by said pressure loss section.
[0047] That is, as for the pressure drawdown rate in the fuel gas supply line 6, and the pressure drawdown rate in fuel gas discharge Rhine 11 and the fuel gas circulation line 12, the pressure drawdown rate of the direction which fuel leakage has generated becomes larger. Therefore, without forming latching valves 8 and 15, it is possible to pinpoint the generating part of fuel gas leakage, and the 3rd operation gestalt considered as the starting configuration is shown below.
[0048] Drawing 5 receives the system configuration Fig. of drawing 1 which shows the fuel cell system of the 3rd operation gestalt, and shows the 1st operation gestalt, adds a pressure gage 9 to fuel gas discharge Rhine 11, and detects a pressure to each with this pressure gage 9 and the pressure gage 7 formed in the fuel gas supply line 6. And detection of fuel gas leakage using said manometers 7 and 9 is

performed by the procedure shown in the flow chart of drawing 6 .
[0049] In the flow chart of drawing 6 , like said step S1 - step S3, on condition that the output current i of a fuel cell 10 is smaller than a threshold i0, at step S31 - step S33, processing which holds compulsorily a purge valve 13 and the reduced pressure regulator valve 3 to a closed state is performed. Here, since the ejector 5 infixed in the closed space of a fuel gas circulation supply system and a fuel cell 10 serve as the pressure loss section, it will be divided into two closed space of the fuel gas supply line 6, and the fuel gas discharge Rhine 11 and the fuel gas circulation line 12 in false.
[0050] At step S34, with said output current breaker 30, the output of the output current i is intercepted and a generation of electrical energy (consumption of fuel gas) of a fuel cell 10 is stopped. Two closed space which does not show the fall with a pressure rapid when there is no leakage of fuel gas by the above-mentioned processing is formed in false. In step S35, based on the detection pressure force P1 of a pressure gage 7, Variation delta P1/delta t (pressure drop rate) is calculated, and Variation delta P2/delta t (pressure drop rate) is calculated at step S36 based on the detection pressure force P2 of a pressure gage 9.
[0051] step S37 -- step S -- it distinguishes whether variation delta P/delta t which chose the larger one of the variation deltaP1 computed by 35 and 36/delta P2 [delta t and]/the delta t (the one where fall velocity is quicker), and was chosen at step S37 in step S38 is larger than a threshold A. And when larger than a threshold A, while variation delta P/delta t progresses to step S39 and performs the output and leak-detection display output of a leak-detection signal, a fuel gas leakage generating part is made to memorize by memorizing the pressure gages 7 and 9 which progressed to step S40, for example, detected leakage generating.
[0052] Although considered as the configuration which detects the leakage of fuel gas with the above 1st - the 3rd operation gestalt based on the pressure drawdown in the closed space of the fuel gas circulation supply system containing the fuel cell 10 with which supply of fuel gas was intercepted and the generation of electrical energy was stopped Although there is no consumption of the fuel in a fuel cell 10 when the leakage of fuel gas occurs, the flow of fuel gas will occur in a closed space, and order differential pressure will be produced in the pressure loss sections, such as an ejector 5, a fuel cell 10, and the reduced pressure regulator valve 3.
[0053] So, with the 4th operation gestalt shown below, fuel gas leakage is detected based on said order differential pressure. Drawing 7 is what shows the fuel cell system of the 4th operation gestalt. The 1st differential pressure gage 16 which detects the differential pressure of the fuel gas supply line 2 before and behind the reduced pressure regulator valve 3, and the fuel gas supply line 4, The 2nd differential pressure gage 17 which detects the differential pressure of the fuel gas supply line 4 before and behind an ejector 5, and the fuel gas supply line 6, The 3rd differential pressure gage 18 which detects the differential pressure of the fuel gas circulation line 12 before and behind an ejector 5 and the fuel gas supply line 6, and the 4th differential pressure gage 19 which detects the differential pressure of the fuel gas supply line 6 before and behind a fuel cell 10 and fuel gas discharge Rhine 11 are formed.
[0054] The differential pressure output value of each differential pressure gages 16-19 (a pressure condition detection means, differential pressure detection means) is set to delta P1, delta P2, delta P3, and delta P4 here. And the pressure-sensitive polarity of each differential pressure gages 16-19 The value of the plus as said differential pressure output values delta P1, delta P2, delta P3, and delta P4 when the near pressure shown in drawing 7 with a plus sign is relatively high shall be outputted. And detection of fuel gas leakage using said differential pressure gages 16-19 is performed by the procedure shown in the flow chart of drawing 8 .
[0055] First, at step S51, it distinguishes whether the output current i (electric load) is smaller than a threshold i0. And when smaller than a threshold i0, it progresses to step S52 and a purge valve 13 is compulsorily held to a closed state, and at the following step S53, with said output current breaker 30, the output current i (electric load) intercepts the output of the output current i, and stops a generation of electrical energy (consumption of fuel gas) of a fuel cell 10.
[0056] At step S54, the output values delta P1, delta P2, delta P3, and delta P4 of each differential pressure gages 16-19 are read. At step S55, the read output values delta P1, delta P2, delta P3, and delta

P4 compare and judge the threshold A which determined beforehand whether it would be larger than the minute pressure variation within an electrical signal noise or the design value of a fuel cell system as the absolute value of each output values delta P1, delta P2, delta P3, and delta P4.
[0057] Here, when all the output values delta P1, delta P2, delta P3, and delta P4 are below the thresholds A, it progresses to step S56, and considers that the detection differential pressure of all the differential pressure gages 16-19 is 0, and the judgment without fuel gas leakage is made at the following step S57. When all detection differential pressure is 0, it is shown that the flow of the fuel gas in the fuel gas circulation supply lines 4, 6, 11, and 12 has stopped, and since it agrees with the condition of having stopped in piping without consuming fuel gas, since this stopped the generation of electrical energy of a fuel cell 10, it is judged that fuel gas leakage is not generated.
[0058] If it is judged that there are some which exceed a threshold A in output values delta P1, delta P2, delta P3, and delta P4 at step S55 on the other hand, it will progress to step S58. At step S58, about that the absolute value of whose is below the threshold A among the output values of differential pressure gages 16-19, it is regarded as 0, and only the direction of differential pressure is saved by plus and minus about the thing exceeding a threshold A.
[0059] And at step S59, the generating part of fuel gas leakage is pinpointed based on the comparison with a judgment map as shown in drawing 9 , and an actual differential pressure detection pattern. For example, to the detection result of the 1st differential pressure gage 16 being plus, when the detection result of the 2nd differential pressure gage 17 is 0 or minus, it judges with that from which fuel gas has leaked in the fuel gas supply line 4 (Q0 piping).
[0060] Namely, that the detection result of the 1st differential pressure gage 16 is plus While the flow of the fuel gas which goes [in / the pressure of the downstream is lower than the upstream of the reduced pressure regulator valve 3, and / the reduced pressure regulator valve 3] to a fuel cell 10 side will have occurred When the detection result of the 2nd differential pressure gage 17 is 0 or minus With an ejector 5, the flow which there is no flow or goes to the fuel gas supply line 4 side from the fuel gas supply line 6 side will have arisen, and this will show generating of the fuel gas leakage in the fuel gas supply line 4.
[0061] moreover, when both the detection differential pressure of the 3rd differential pressure gage 18 and the 4th differential pressure gage 19 is minus The pressure of the fuel gas supply line 6 will be lower than fuel gas discharge Rhine 11 and the fuel gas circulation line 12. This The flow which flows into the fuel gas supply line 6 side through a fuel cell 10 from fuel gas discharge Rhine 11 occurs. The flow which flows into coincidence through an ejector 5 at the fuel gas supply line 6 side from the fuel gas circulation line 12 will have occurred, and this will show generating of the fuel gas leakage in the fuel gas supply line 6 (Q1 piping).
[0062] on the contrary, when both the detection differential pressure of the 3rd differential pressure gage 18 and the 4th differential pressure gage 19 is pluses The pressure of fuel gas discharge Rhine 11 and the fuel gas circulation line 12 will be lower than the fuel gas supply line 6. This The flow which flows into the fuel gas discharge Rhine 11 side through a fuel cell 10 from the fuel gas supply line 6 occurs. The flow which flows into coincidence through an ejector 5 at the fuel gas circulation line 12 side from the fuel gas supply line 6 will have occurred, and this will show generating of the fuel gas leakage in fuel gas discharge Rhine 11 and the fuel gas circulation line 12 (Q2 piping).
[0063] In addition, the half-tone-dot-meshing display in drawing 9 can show the minimum combination required for a leakage part judging, and can pinpoint a leakage part only in the combination of a half-tone-dot-meshing part. However, judging from all differential pressure outputs is also possible, and when the conditions which are not indicated by drawing 9 are detected, the whole fuel cell system judges that a certain fault is caused, and you may make it output important alarms, such as an emergency shut down, in that case.
[0064] If a leakage generating part is pinpointed at step S59, in step S60, a judgment result is memorized as hysteresis information in preparation for subsequent repair, at the following step S61, leakage generating will be told by the alarm or display, and the actuation for security will be demanded from an operator. If it is the configuration of detecting the generating flow of the fuel gas accompanying

fuel leakage based on differential pressure as mentioned above, high detection sensitivity can be obtained without being influenced by the absolute pressure in piping, and very small fuel gas leakage can be detected by this, and cost can also be made cheap.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram of the fuel cell system in the 1st operation gestalt.
[Drawing 2] The flow chart which shows the procedure of the leak detection in the 1st operation gestalt.
[Drawing 3] The block diagram of the fuel cell system in the 2nd operation gestalt.
[Drawing 4] The flow chart which shows the procedure of the leak detection in the 2nd operation gestalt.

[Drawing 5] The block diagram of the fuel cell system in the 3rd operation gestalt.
[Drawing 6] The flow chart which shows the procedure of the leak detection in the 3rd operation gestalt.

[Drawing 7] The block diagram of the fuel cell system in the 4th operation gestalt.
[Drawing 8] The flow chart which shows the procedure of the leak detection in the 4th operation gestalt.

[Drawing 9] Drawing showing the judgment map used for a leakage part judging with the 4th operation gestalt.
[Description of Notations]
1 -- Source of hydrogen gas supply
2 -- Fuel gas supply line
3 -- Reduced pressure regulator valve
4 -- Fuel gas supply line
5 -- Ejector
6 -- Fuel gas supply line
7 9 -- Pressure gage
8 15 -- Latching valve
10 -- Fuel cell
11 -- Fuel gas discharge Rhine
12 -- Fuel gas circulation line
13 -- Purge valve
14 -- Purge line
16-19 -- Differential pressure gage
20 -- Oxidant gas source of supply
21 -- Gas supply Rhine
22 -- Discharge Rhine
30 -- Output current breaker
31 -- Ammeter
32 -- Output wiring
40 -- Signal processor

[Translation done.]

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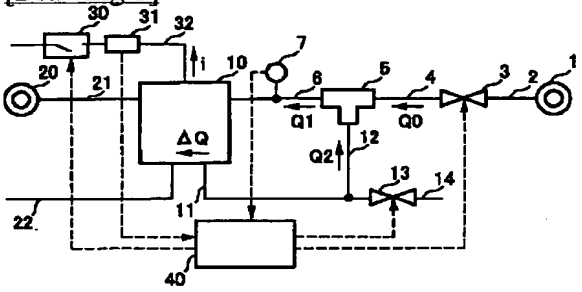
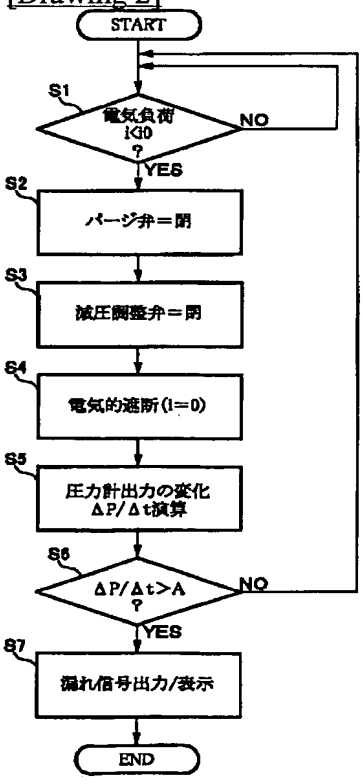
DRAWINGS

[Drawing 1]



[Drawing 2]



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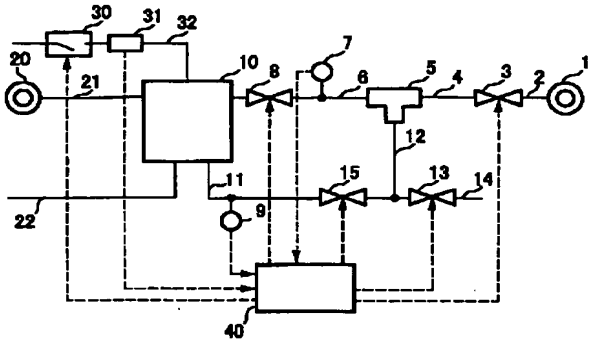

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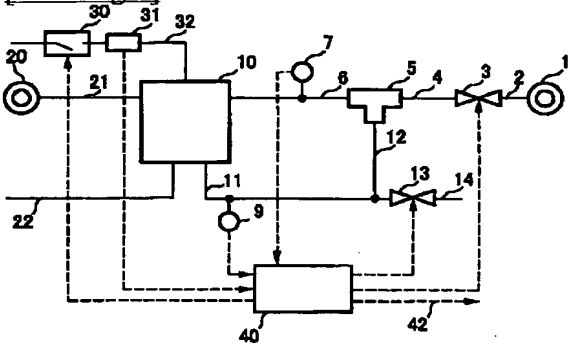

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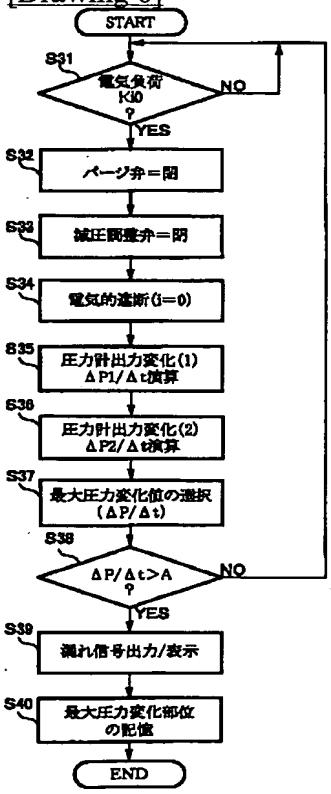

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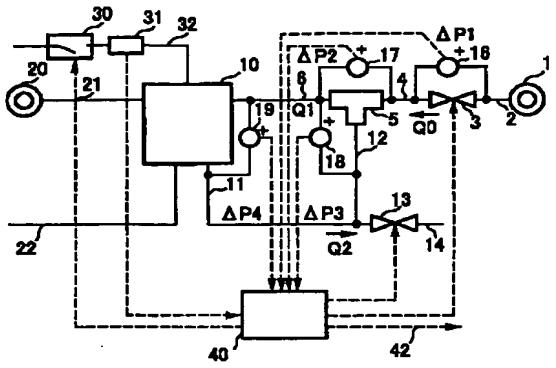
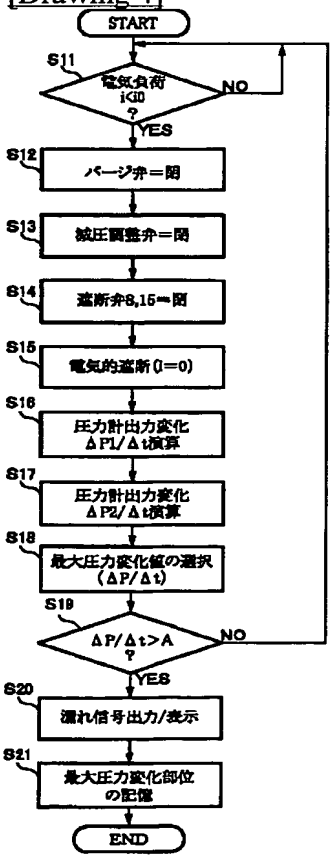


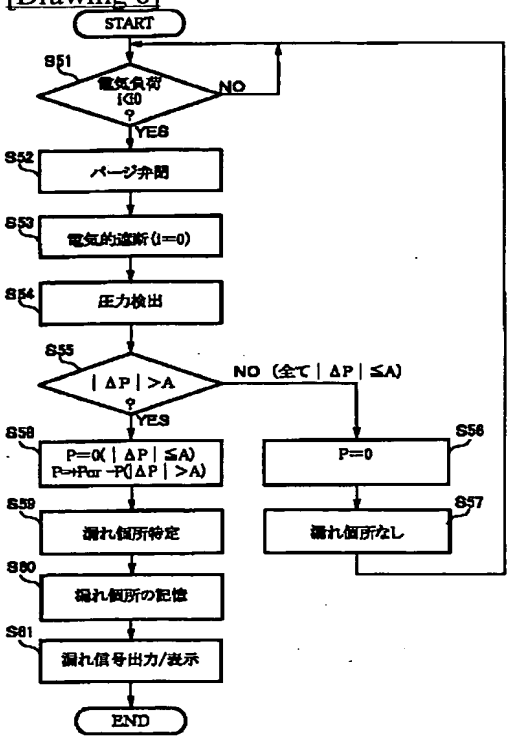
[Drawing 9]

	差圧計出力				漏れ個所
	ΔP1	ΔP2	ΔP3	ΔP4	
1	0	0	0	0	なし
2	+P	0 or -P	0 or -P	0 or -P	Q0配管上
3	0 or +P	+P	-P	-P	Q1配管上
4	0 or +P	+P	+P	+P	Q2配管上

[Drawing 4]



[Drawing 8]



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(71)出願人　000003997
日産自動車株式会社
神奈川県横浜市神奈川区宝町2番地

(72)発明者　酒井　政信
神奈川県横浜市神奈川区宝町2番地　日産自動車株式会社内

(72)発明者　上原　哲也
神奈川県横浜市神奈川区宝町2番地　日産自動車株式会社内

(74)代理人　100078330
弁理士　笹島　富二雄

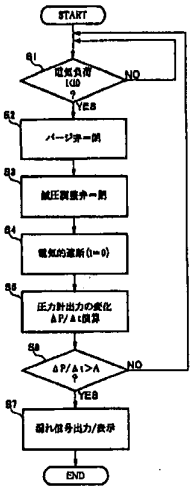
最終頁に続く

(54)【発明の名称】燃料電池システムのガス漏れ検知方法及び装置

(57)【要約】

【課題】　車両用燃料電池システムにおいて、燃料ガス循環供給系からの燃料ガスの漏れを、運転中に検知できる低廉な検知装置を提供する。

【解決手段】　減速エネルギーの回生時などで、燃料電池の出力電流ｉが閾値よりも小さくなると（Ｓ１）、出力電流遮断器によって出力電流ｉを遮断して、燃料電池の発電を停止させる一方（Ｓ４）、循環系から燃料ガスと共に水を排出させるためのパージ弁、及び、燃料供給源からの燃料ガスの供給を制御する減圧調整弁を強制的に閉じる（Ｓ２，Ｓ３）。このときに、燃料ガス循環供給系の閉空間内の圧力を圧力計で検出し、該圧力計の検出結果が、基準以上の速度での圧力降下を示す場合には、燃料ガス漏れの発生を判定する（Ｓ５～Ｓ７）。



【特許請求の範囲】

【請求項１】燃料電池の電気負荷が閾値よりも小さいときに、前記燃料電池の出力電流を遮断し、このときの前記燃料電池を含む燃料ガス循環供給系の閉空間における圧力状態に基づいて、前記閉空間における燃料ガス漏れを検知することを特徴とする燃料電池システムのガス漏れ検知方法。

【請求項２】前記閉空間への燃料供給源からの燃料ガスの供給を強制的に遮断し、該閉空間における圧力降下速度に基づいて燃料ガス漏れを検知することを特徴とする請求項１記載の燃料電池システムのガス漏れ検知方法。

【請求項３】前記閉空間内の圧力損失部の前後差圧に基づいて燃料ガス漏れを検知することを特徴とする請求項１記載の燃料電池システムのガス漏れ検知方法。

【請求項４】燃料電池，燃料供給源，燃料ガス循環供給系を含んで構成される燃料電池システムにおいて、

前記燃料電池の出力電流を遮断する出力電流遮断手段と、

前記燃料電池を含む燃料ガス循環供給系の閉空間内の圧力状態を検出する圧力状態検出手段と、

前記燃料電池の電気負荷が閾値よりも小さい状態を判別する電気負荷判別手段と、

該電気負荷判別手段で燃料電池の電気負荷が閾値よりも小さいと判別されたときに、前記出力電流遮断手段により燃料電池の出力電流を遮断する遮断制御手段と、

該遮断制御手段により出力電流の遮断が行われているときに、前記圧力状態検出手段で検出される圧力状態に基づいて、前記閉空間からの燃料ガス漏れの有無を判断する燃料ガス漏れ判断手段と、

を含んで構成されたことを特徴とする燃料電池システムのガス漏れ検知装置。

【請求項５】燃料電池，燃料供給源，燃料ガス循環供給系を含んで構成される燃料電池システムにおいて、

前記燃料電池の出力電流を遮断する出力電流遮断手段と、

前記燃料ガス循環供給系への燃料供給源からの燃料ガスの供給を強制的に遮断する供給源遮断手段と、

前記燃料電池を含む燃料ガス循環供給系の閉空間内における圧力を検出する圧力検出手段と、

前記燃料電池の電気負荷が閾値よりも小さい状態を判別する電気負荷判別手段と、

該電気負荷判別手段で燃料電池の電気負荷が閾値よりも小さいと判別されたときに、前記出力電流遮断手段により燃料電池の出力電流を遮断すると共に、前記供給源遮断手段により燃料供給源からの燃料ガスの供給を強制的に遮断させる遮断制御手段と、

該遮断制御手段により出力電流の遮断及び前記燃料供給源からの燃料ガスの供給が強制的に遮断されるときに、前記圧力検出手段で検出される圧力の降下速度に基づいて、前記閉空間からの燃料ガス漏れの有無を判断する燃料ガス漏れ判断手段と、

を含んで構成されたことを特徴とする燃料電池システムのガス漏れ検知装置。

【請求項６】前記燃料電池を含む燃料ガス循環供給系の閉空間を複数の閉空間に遮断する閉空間分割手段を備えると共に、前記圧力検出手段が前記複数の閉空間それぞれの圧力を検出するよう構成し、前記燃料ガス漏れ判断手段が、前記複数の閉空間毎の圧力降下速度に基づいて、燃料ガス漏れの有無及び燃料ガス漏れの発生箇所を判断することを特徴とする請求項５記載の燃料電池システムのガス漏れ検知装置。

【請求項７】前記圧力検出手段が、前記閉空間内の圧力損失部の間における圧力を複数箇所でそれぞれに検出し、前記燃料ガス漏れ判断手段が、それぞれの検出部位における圧力降下速度に基づいて、燃料ガス漏れの有無及び燃料ガス漏れの発生箇所を判断することを特徴とする請求項５記載の燃料電池システムのガス漏れ検知装置。

【請求項８】前記燃料ガス漏れ判断手段が、前記それぞれの検出部位における圧力降下速度のうちの最も大きな圧力降下速度が閾値よりも大きいときに、最も大きな降下速度を示した検出部位での燃料ガス漏れの発生を判断することを特徴とする請求項７記載の燃料電池システムのガス漏れ検知装置。

【請求項９】燃料電池，燃料供給源，燃料ガス循環供給系を含んで構成される燃料電池システムにおいて、

前記燃料電池の出力電流を遮断する出力電流遮断手段と、

前記燃料電池を含む燃料ガス循環供給系の閉空間における少なくとも１つの圧力損失部の前後差圧を検出する差圧検出手段と、

前記燃料電池の電気負荷が閾値よりも小さい状態を判別する電気負荷判別手段と、

該電気負荷判別手段で燃料電池の電気負荷が閾値よりも小さいと判別されたときに、前記出力電流遮断手段により燃料電池の出力電流を遮断する遮断制御手段と、

該遮断制御手段により出力電流の遮断が行われているときに、前記差圧検出手段で検出される差圧に基づいて、前記閉空間からの燃料ガス漏れの有無を判断する燃料ガス漏れ判断手段と、

を含んで構成されたことを特徴とする燃料電池システムのガス漏れ検知装置。

【請求項１０】前記差圧検出手段が、前記閉空間内における複数の圧力損失部の前後差圧をそれぞれに検出し、前記燃料ガス漏れ判断手段が、前記前後差圧が閾値よりも大きいときに、燃料ガス漏れの発生を判断すると共に、隣接する検出部それぞれでの差圧の方向に基づいて燃料ガス漏れの発生箇所を判断することを特徴とする請求項９記載の燃料電池システムのガス漏れ検知装置。

【請求項１１】前記燃料電池システムが、燃料ガス循環

供給系の循環系からのパージを制御するパージ手段を含んで構成され、
前記燃料ガス漏れ判断手段による燃料ガス漏れの判断を行わせるときに、前記パージ手段によるパージを強制的に遮断して前記閉空間を形成させるパージ遮断手段を設けたことを特徴とする請求項４～１０のいずれか１つに記載の燃料電池システムのガス漏れ検知装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、燃料電池システムのガス漏れ検知方法及び装置に関し、詳しくは、燃料ガスの漏れを燃料電池システム内部で検知する方法及び装置に関する。

【０００２】

【従来の技術】従来、燃料電池システムにおいて、水素含有燃料ガスの漏れを検知する方法として、特開平１１－２２４６８１号公報や特開平８－３２９９６５号公報に開示される方法があった。前記特開平１１－２２４６８１号公報に開示される方法は、燃料電池の出力電流値に基づいて、燃料電池における燃料ガスの使用量を算出し、この燃料ガス使用量から燃料ガスボンベ内の燃料ガス圧力を算出して、この算出圧力と実際に圧力センサで検出した圧力値とを比較することにより、燃料ガスの漏洩を判断するものである。

【０００３】また、特開平８－３２９９６５号公報に開示される方法は、燃料電池の上流部と下流部に各々弁を設けて、発電運転前に前記弁を閉じることで燃料ガスを封入し、その圧力変化を圧力検知手段で検知して、封入圧力の低下に基づいて燃料ガスの漏洩を検知するようにしている。

【０００４】

【発明が解決しようとする課題】しかしながら、特開平１１－２２４６８１号公報に開示される方法では、パージ制御による燃料ガスの消費を、漏れとして誤検出する可能性があるという問題があった。燃料電池システムでは、燃料電池に供給される加湿水素含有燃料ガスに含まれる水蒸気が燃料極の周りで水となり、水が排出経路に充満するほどになると燃料電池の出力低下に至るフラッディング現象が生じる。

【０００５】上記フラッディング現象の対策として、例えば燃料電池の出力低下に基づいて水の充満を判断すると、燃料ガスを用いて水をパージさせるようにしている。ここで、パージのために使われた燃料ガスは燃料電池の出力にはほとんど寄与しないので、パージのために使われた燃料ガスが漏れ分として算出されることになり、漏れを高精度に検出させようとすると、パージ実行時に漏れの発生が誤検出されるという問題が生じることになる。

【０００６】また、特開平８－３２９９６５号公報に開示される方法は、圧力計の値を監視することで燃料ガス漏れの有無を判断できるため低廉な検知方法ではあるが、始動前に漏れを検出する方法であるため、運転開始後の漏れ発生は、再度始動されるまでの間検出されないという欠点があった。特に車両用の燃料電池システムでは、走行に伴って生じる機械的な振動や衝撃の入力、更には、熱的な変化を大きく受けて熱変形するなど、漏れが生じる可能性は圧倒的に走行中に多い。

【０００７】従って、従来例のように始動前でしか検出できない漏れ検出方法では、車両用の燃料電池システムに対して必要な検出性能を確保できないという問題が生じることになる。本発明は上記問題点に鑑みなされたものであり、燃料ガスの漏れを運転中でも検出でき、然も低廉な、燃料電池システムのガス漏れ検知方法及び装置を提供することにある。

【０００８】

【課題を解決するための手段】そのため、請求項１，４記載の発明に係る検知方法及び装置では、燃料電池の電気負荷が閾値よりも小さいときに燃料電池の出力電流を遮断し、このときの燃料電池を含む燃料ガス循環供給系の閉空間における圧力状態に基づいて、前記閉空間における燃料ガス漏れを検知する構成とした。

【０００９】上記構成によると、燃料電池の電気負荷が閾値よりも小さく、燃料電池の発電を止めることができる状態になると、燃料電池の出力電流を遮断することで燃料電池の発電を止める。発電を止めると、燃料電池で燃料ガスが消費されない状態になり、燃料電池を含む燃料ガス循環供給系の閉空間における圧力状態が、漏れのみに影響されるようになるから、圧力状態から燃料ガス漏れの有無を検知する。

【００１０】請求項２，５記載の発明に係る検知方法及び装置では、燃料電池の電気負荷が閾値よりも小さいときに燃料電池の出力電流を遮断すると共に、前記閉空間への燃料供給源からの燃料ガスの供給を強制的に遮断し、このときの閉空間における圧力降下速度に基づいて燃料ガス漏れを検知する構成とした。上記構成によると、燃料供給源からの燃料ガスの供給が遮断される閉空間では、漏れによって燃料ガスが外部に流出すると、閉空間内の圧力が、漏れがないときに比べて急激に低下することになるから、圧力降下速度が漏れの発生を示す程度に大きいか否かに基づいて漏れの発生を検知する。

【００１１】請求項３，９記載の発明に係る検知方法及び装置では、前記閉空間内の圧力損失部の前後差圧を検出し、この前後差圧に基づいて燃料ガス漏れを検知する構成とした。上記構成によると、閉空間からの漏れが発生すると、閉空間内に燃料ガスの流れが発生し、該流れによって圧力損失部の前後に差圧が生じることになるので、圧力損失部の前後差圧に基づいて燃料ガスの流れの発生を検知し、以って、燃料ガス漏れの有無を検知する。

【００１２】請求項６記載の発明に係る検知装置では、

前記閉空間内の圧力降下速度に基づいて燃料ガス漏れを検知する構成において、出力電流の遮断によって漏れの検知を行わせるときに、燃料電池を含む燃料ガス循環供給系の閉空間を複数の閉空間に遮断し、かつ、該複数の閉空間それぞれの圧力を検出するよう構成し、前記複数の閉空間毎の圧力降下速度に基づいて、燃料ガス漏れの有無及び燃料ガス漏れの発生箇所を判断する構成とした。

【００１３】上記構成によると、燃料供給源からの燃料ガスの供給が遮断される閉空間を、複数に遮断し、該複数の閉空間毎に圧力を検出させることで、燃料ガス漏れの発生箇所を、前記複数の閉空間のいずれかに特定する。請求項７記載の発明に係る検知装置では、前記閉空間内の圧力降下速度に基づいて燃料ガス漏れを検知する構成において、前記閉空間内の圧力損失部の間における圧力を複数箇所でそれぞれに検出し、それぞれの検出部位における圧力降下速度に基づいて、燃料ガス漏れの有無及び燃料ガス漏れの発生箇所を判断する構成とした。

【００１４】上記構成によると、圧力損失部を境界とする擬似的な閉空間を複数設定し、該擬似閉空間毎の圧力降下速度から、燃料ガス漏れの発生箇所を、前記擬似閉空間のいずれかに特定する。請求項８記載の発明に係る検知装置では、請求項７の構成において、それぞれの検出部位における圧力降下速度のうちの最も大きな圧力降下速度が閾値よりも大きいときに、最も大きな降下速度を示した検出部位での燃料ガス漏れの発生を判断する構成とした。

【００１５】上記構成によると、一箇所での燃料ガス漏れが圧力損失部を介して他の検出圧力に影響を与えることになるが、燃料ガス漏れの発生箇所での圧力降下が最も大きくなるから、最も大きな降下速度を示した検出部位を燃料ガス漏れの発生箇所として特定する。請求項１０記載の発明に係る検知装置では、前記閉空間内の圧力損失部の前後差圧に基づいて燃料ガス漏れを検知する構成において、前記閉空間内における複数の圧力損失部の前後差圧をそれぞれに検出し、前記前後差圧が閾値よりも大きいときに燃料ガス漏れの発生を判断すると共に、隣接する検出部それぞれの差圧の方向に基づいて燃料ガス漏れの発生箇所を判断する構成とした。

【００１６】上記構成によると、圧力損失部の前後差圧の方向から、燃料ガスの流れ方向を特定でき、これに基づいて燃料ガス漏れの発生箇所を特定する。請求項１１記載の発明に係る検知装置では、燃料ガス漏れの有無を判断させるときに、パージ手段による循環系からのパージを強制的に遮断して前記閉空間を形成させる構成とした。

【００１７】上記構成によると、燃料ガス循環供給系を閉空間として漏れ検出を行わせることができるように、パージを強制的に遮断する。

【００１８】

【発明の効果】請求項１，４記載の発明によると、燃料電池の電気負荷が閾値よりも小さいときに燃料電池の出力電流を遮断して、燃料ガスが消費されない閉空間を形成させるから、例えば、車両用燃料電池システムでは、減速エネルギーの回生が行われるときなど、燃料電池の出力電流が小さい、或いは、出力電流の必要がないときに、燃料漏れの検知を行わせることができ、運転途中に比較的低廉な圧力計によって燃料ガス漏れの検知が行えるという効果がある。

【００１９】請求項２，５記載の発明によると、燃料供給源からの燃料ガスの供給が遮断される閉空間内の圧力降下に基づいて漏れの検知を行わせるから、簡便な構成で運転途中に燃料ガス漏れの検知が行えるという効果がある。請求項３，９記載の発明によると、閉空間内の圧力損失部の前後差圧に基づいて、燃料ガス漏れによって生じる燃料ガスの流れを検出させるので、閉空間内の絶対圧に影響されることなく、然も、高精度に燃料ガス漏れの発生を検知することができるという効果がある。

【００２０】請求項６記載の発明によると、複数に遮断される閉空間毎の圧力降下に基づいて、燃料ガス漏れの発生箇所を、精度良く特定することができるという効果がある。請求項７記載の発明によると、燃料ガス循環供給系を、弁などを用いて複数に区分することなしに、燃料ガス漏れの発生箇所を特定することができ、漏れ箇所の特定を簡便な構成で行わせることができるという効果がある。

【００２１】請求項８記載の発明によると、燃料ガス漏れの影響が、圧力損失部を介して他の圧力検出部位に影響を与えても、燃料ガス漏れの発生箇所を圧力降下速度から精度良く特定することができるという効果がある。請求項１０記載の発明によると、圧力損失部の前後差圧から、燃料ガス漏れに伴う燃料ガスの流れ方向を特定して、燃料ガス漏れの発生箇所を精度良く特定することができるという効果がある。

【００２２】請求項１１記載の発明によると、燃料ガス漏れの検出に必要な閉空間を、確実に形成させて、燃料電池の電気負荷が閾値よりも小さいときに確実に燃料ガス漏れの検知を行わせることができるという効果がある。

【００２３】

【発明の実施の形態】以下に本発明の実施の形態を図に基づいて説明する。図１は、第１の実施形態における車両用燃料電池システムを示す図である。この図１において、水素ガス供給源１（燃料供給源）からの燃料ガスは、燃料ガス供給ライン２，減圧調整弁３，燃料ガス供給ライン４，エジェクタ５，燃料ガス供給ライン６を介して、燃料電池１０の燃料極（図示省略）に導入され、燃料電池１０にて消費されなかった燃料ガスは、燃料ガス排出ライン１１及び燃料ガス循環ライン１２を介し、前記エジェクタ５によって燃料ガス供給ライン６に還流

される。

【００２４】上記燃料ガス供給ライン２，減圧調整弁３（供給源遮断手段），燃料ガス供給ライン４，エジェクタ５，燃料ガス供給ライン６，燃料ガス排出ライン１１及び燃料ガス循環ライン１２によって、燃料ガス循環供給系が構成される。前記燃料ガス排出ライン１１には、パージ弁１３が介装されるパージライン１４が接続されている。

【００２５】上記パージ弁１３及びパージライン１４によってパージ手段が構成される。前記パージ弁１３は、燃料ガス排出ライン１１に溜まった水を燃料ガスと共に排出させるときに開制御される。一方、燃料電池１０の空気極（図示省略）には、酸化ガス供給源２０からの酸化ガス（空気）がガス供給ライン２１を介して供給され、燃料電池１０にて消費されなかった酸化ガスは、排出ライン２２を介して排出される。

【００２６】また、前記燃料電池１０の出力電流ｉを出力する出力配線３２には、出力電流ｉを検出する電流計３１、及び、前記出力電流ｉを遮断する出力電流遮断器３０（出力電流遮断手段）が介装される。更に、前記燃料ガス供給ライン６内の圧力を検出する圧力計７（圧力状態検出手段，圧力検出手段）が設けられている。

【００２７】前記電流計３１及び圧力計７の検出出力が入力される信号処理装置４０は、前記パージ弁１３及び出力電流遮断器３０の開閉動作を制御すると共に、減圧調整弁３を強制的に遮断させる機能を有している。上記構成において、水素ガス供給源１から燃料ガス流量Ｑ０が供給され、エジェクタ５で還流ガス流量Ｑ２を加えた流量Ｑ１（＝Ｑ０＋Ｑ２）が燃料電池１０の燃料極に導かれる。

【００２８】燃料電池１０では、出力電流ｉに見合ったΔＱの流量が消費され、残った燃料ガスＱ２が循環し、燃料ガス供給ライン６に還流されるようになっている。即ち、燃料電池１０の燃料極に供給される燃料ガス流量は、ΔＱ＝Ｑ１－Ｑ２＝Ｑ０の関係があり、前記減圧調整弁３は、燃料電池１０における消費燃料量（燃料ガス循環供給ラインの圧力低下）に見合った燃料ガスを供給する。

【００２９】ここで、車両で要求される電気負荷、即ち、出力電流ｉは、非常に大きく変動し得る値であり、例えば車両制動時（減速時）に、車両慣性エネルギーを電気エネルギーに変換する回生制動装置を備える場合には、電気エネルギーが回生制動によって供給され得るために、燃料電池１０からの出力電流ｉが不要、或いは、極めて小さな値になり、このとき減圧調整弁３は燃料ガスの流れを遮断するか供給量Ｑ０を微小に絞ることになる。

【００３０】そして、回生制動が終了すれば出力電流をゼロ（又は微小値）にする条件が解除されるため、車両電気負荷に対応する要求電流ｉに見合った燃料ガス消費流量が再現されて、燃料供給流量Ｑ０も流れ出すようになる。このように、車両用の燃料電池システムにおいては、常時燃料電池１０の発電が要求されるものではなく、燃料電池１０の発電を停止させることができる状態が運転中に発生する。

【００３１】燃料電池１０の発電が停止される状態では、燃料ガスが燃料電池１０で消費されないから、パージ弁１３が閉じていて閉空間を形成する状態であれば、燃料ガスが閉空間内に閉じ込められることになって大きな圧力変化は発生しない。ここで、水素ガス供給源１からの燃料ガスの供給が遮断されていれば、閉空間からの燃料ガスの漏れが発生したときに、前記閉空間の圧力が降下することになり、係る圧力降下に基づいて燃料ガス漏れの発生を推定することができる。

【００３２】そこで、前記信号処理装置４０は、図２のフローチャートに示すような手順によって燃料ガス漏れの有無を検知する。尚、前記信号処理装置４０は、図２のフローチャートに示すように、電気負荷判別手段，遮断制御手段，燃料ガス漏れ判断手段，パージ遮断手段としての機能を備えている。

【００３３】まず、ステップＳ１では、出力電流ｉ（電気負荷）が閾値ｉ０よりも小さいか否かを判別する。そして、出力電流ｉ（電気負荷）が閾値ｉ０よりも小さいときには、ステップＳ２へ進み、パージ弁１３を強制的に閉状態に保持し、次のステップＳ３では、減圧調整弁３を強制的に閉状態に保持させるようにする。

【００３４】尚、減圧調整弁３の上流側又は下流側に遮断弁を設けて、水素ガス供給源１からの燃料ガスの供給を強制的に遮断させる構成としても良い。更に、ステップＳ４では、前記出力電流遮断器３０によって出力電流ｉの出力を遮断し、燃料電池１０の発電（燃料ガスの消費）を止める。上記処理によって、水素ガス供給源１からの燃料ガスの供給が遮断される燃料電池１０を含む閉空間が機械的に形成される一方、燃料電池１０における燃料ガスの消費が０になり、前記閉空間からの燃料ガスの漏れがない場合には、前記圧力計７で検出される圧力が大きな変化を示すことはない。

【００３５】ステップＳ５では、前記閉空間内における圧力降下速度を示す、前記圧力計７による検出圧力Ｐの単位時間Δｔ当たりの変化量ΔＰ／Δｔを演算する。尚、前記変化量ΔＰ／Δｔは、圧力Ｐの減少変化に対してプラスの値に算出されるものとする。そして、ステップＳ６では、前記変化量ΔＰ／Δｔが閾値Ａよりも大きいか否かを判別する。

【００３６】前記変化量ΔＰ／Δｔが閾値Ａを超え、圧力Ｐの減少速度が基準値を超えていると判断されるときには、閉空間からの燃料ガスの漏れによって所定以上の速度で圧力降下しているものと判断し、ステップＳ７へ進んで、漏れ検知信号の出力及び漏れ検知表示出力を行う。前記漏れ検知表示出力は、例えば車両の運転席付近

に設けた警告灯の点灯などを行う制御信号である。

【００３７】上記実施形態による燃料ガス漏れ検知では、運転中に出力電流ｉ（電気負荷）が閾値ｉ０よりも小さくなる毎（例えば減速運転毎）に、燃料ガス漏れの有無を判断させることができるため、燃料ガス漏れの発生を応答良く検知できると共に、比較的低廉な圧力計７を用いるため、低コストで漏れ検知装置を構成できる。ところで、上記実施形態では、減圧調整弁３，燃料ガス供給ライン４，エジェクタ５，燃料ガス供給ライン６，燃料電池１０，燃料ガス排出ライン１１及び燃料ガス循環ライン１２を含んでなる燃料ガス循環供給系の閉空間に対して、１つの圧力計７を設ける構成であるため、閉空間のいずれかで燃料ガス漏れが発生していることを検知できるものの、漏れ発生箇所を限定することができない。

【００３８】そこで、図３に示す第２の実施形態に示すように、燃料ガス循環供給系の閉空間を、更に２つの閉空間に分割遮断する遮断弁８，１５（閉空間分割手段）を設けると共に、該遮断弁８，１５で遮断される閉空間毎に圧力計７，９を設けるようにして、いずれの圧力検出値が、所定以上の圧力降下速度を示すかによって、燃料ガス漏れの箇所を前記２つの閉空間のいずれかに特定することができる。

【００３９】具体的には、燃料ガス供給ライン６の途中に第１遮断弁８を介装し、かつ、燃料ガス排出ライン１１の途中に第２遮断弁１５を介装する一方、第１遮断弁８とエジェクタ５との間の燃料ガス供給ライン６内の圧力を検出するように圧力計７を設け，第２遮断弁１５と燃料電池１０との間の燃料ガス排出ライン１１内の圧力を検出するように圧力計９を設けてある。

【００４０】そして、第２の実施形態では、図４のフローチャートに示すようにして漏れ検知を行う。図４のフローチャートにおいて、ステップＳ１１～ステップＳ１３では、前記ステップＳ１～ステップＳ３と同様に、燃料電池１０の出力電流ｉが閾値ｉ０よりも小さいことを条件に、パージ弁１３及び減圧調整弁３を強制的に閉状態に保持する処理を行う。

【００４１】更に、次のステップＳ１４で前記遮断弁８，１５を閉じることで、燃料ガス循環供給系の閉空間を２つに分割遮断する。そして、ステップＳ１５では、前記出力電流遮断器３０によって出力電流ｉの出力を遮断し、燃料電池１０の発電（燃料ガスの消費）を止める。上記処理により、燃料ガスの漏れがない場合には圧力が急激な低下を示すことのない２つの閉空間が形成される。

【００４２】ステップＳ１６では、圧力計７の検出圧力Ｐ１に基づいて、変化量ΔＰ１／Δｔ（圧力低下速度）を演算し、ステップＳ１７では、圧力計９の検出圧力Ｐ２に基づいて、変化量ΔＰ２／Δｔ（圧力低下速度）を演算する。ステップＳ１８では、ステップＳ１６，１７で算出した変化量ΔＰ１／Δｔ，ΔＰ２／Δｔのうちの大きい方（降下速度が速い方）を選択し、ステップＳ１９では、ステップＳ１８で選択した変化量ΔＰ／Δｔが閾値Ａよりも大きいか否かを判別する。

【００４３】そして、変化量ΔＰ／Δｔが閾値Ａよりも大きいときには、ステップＳ２０へ進み、漏れ検知信号の出力及び漏れ検知表示出力を行うと共に、ステップＳ２１へ進んで、例えば漏れ発生を検知した圧力計７，９を記憶することで、燃料ガス漏れ発生部位を記憶させる。漏れ発生箇所を記憶することで、例えば漏れが一時的に発生し、その後漏れ部が塞がって警報が出力されなくなっても、漏れの履歴及び漏れ発生箇所を後から知ることができる。

【００４４】尚、漏れ発生箇所の記憶は、前記信号処理装置４０内のメモリ等を用いても良いし、個別に設けた記憶装置に記憶させても良い。本実施形態では、閉空間を遮断弁８，１５によって２つに分割遮断したから、例えば、圧力計７の検出圧力の降下速度が他方よりも大きく、かつ、閾値Ａを超える値を示した場合には、遮断弁１５から燃料ガス循環ライン１２，エジェクタ５を経由して遮断弁８に至る閉空間のいずれかで燃料ガス漏れが発生していることになり、逆に、圧力計９の検出圧力の降下速度が他方よりも大きく、かつ、閾値Ａを超える値を示した場合には、遮断弁８から燃料電池１０，燃料ガス排出ライン１１を経由して遮断弁１５に至る閉空間のいずれかで燃料ガス漏れが発生していることになる。

【００４５】尚、上記実施形態では、閉空間を２つに分割遮断してそれぞれに圧力計を設けることで、２つの閉空間のいずれか一方に漏れ発生箇所を特定できる構成としたが、分割遮断する閉空間の数を３つ以上とし、それぞれに圧力計を備えるようにすれば、より細かく燃料ガス漏れ箇所を特定することができる。但し、実用上は燃料ガス供給システムの規模や配管構造等により必要数を決定すれば良い。

【００４６】また、上記第２実施形態では、遮断弁８，１５によって閉空間を機械的に遮断し、相互に独立した２つの閉空間を形成する構成としたが、燃料ガス循環供給ラインに介装されるエジェクタ５，燃料電池１０は圧力損失部を構成し、燃料漏れの箇所での圧力降下が閉空間の全てに影響するものの、その影響度合いは、前記圧力損失部により制限される。

【００４７】即ち、燃料ガス供給ライン６での圧力降下速度と、燃料ガス排出ライン１１及び燃料ガス循環ライン１２での圧力降下速度とは、燃料漏れが発生している方の圧力降下速度がより大きくなる。従って、遮断弁８，１５を設けることなく、燃料ガス漏れの発生箇所を特定することが可能であり、係る構成とした第３の実施形態を以下に示す。

【００４８】図５は第３の実施形態の燃料電池システムを示すものであり、第１の実施形態を示す図１のシステ

ム構成図に対して、燃料ガス排出ライン１１に圧力計９を追加して、該圧力計９と燃料ガス供給ライン６に設けられる圧力計７とによって、それぞれに圧力を検出する。そして、前記圧力計７，９を用いた燃料ガス漏れの検知は、図６のフローチャートに示す手順で行われる。

【００４９】図６のフローチャートにおいて、ステップＳ３１～ステップＳ３３では、前記ステップＳ１～ステップＳ３と同様に、燃料電池１０の出力電流ｉが閾値ｉ０よりも小さいことを条件に、パージ弁１３及び減圧調整弁３を強制的に閉状態に保持する処理を行う。ここで、燃料ガス循環供給系の閉空間に介装されるエジェクタ５，燃料電池１０が圧力損失部となるため、擬似的に、燃料ガス供給ライン６と、燃料ガス排出ライン１１及び燃料ガス循環ライン１２との２つの閉空間に分けられることになる。

【００５０】ステップＳ３４では、前記出力電流遮断器３０によって出力電流ｉの出力を遮断し、燃料電池１０の発電（燃料ガスの消費）を止める。上記処理により、燃料ガスの漏れがない場合には圧力が急激な低下を示すことのない２つの閉空間が擬似的に形成される。ステップＳ３５では、圧力計７の検出圧力Ｐ１に基づいて、変化量ΔＰ１／Δｔ（圧力低下速度）を演算し、ステップＳ３６では、圧力計９の検出圧力Ｐ２に基づいて、変化量ΔＰ２／Δｔ（圧力低下速度）を演算する。

【００５１】ステップＳ３７では、ステップＳ３５，３６で算出した変化量ΔＰ１／Δｔ，ΔＰ２／Δｔのうちの大きい方（降下速度が速い方）を選択し、ステップＳ３８では、ステップＳ３７で選択した変化量ΔＰ／Δｔが閾値Ａよりも大きいか否かを判別する。そして、変化量ΔＰ／Δｔが閾値Ａよりも大きいときには、ステップＳ３９へ進み、漏れ検知信号の出力及び漏れ検知表示出力を行うと共に、ステップＳ４０へ進んで、例えば漏れ発生を検知した圧力計７，９を記憶することで、燃料ガス漏れ発生部位を記憶させる。

【００５２】上記第１～第３実施形態では、燃料ガスの供給が遮断され、かつ、発電が止められた燃料電池１０を含む燃料ガス循環供給系の閉空間における圧力降下に基づいて、燃料ガスの漏れを検知する構成としたが、燃料ガスの漏れが発生すると、燃料電池１０での燃料の消費がないにも関わらずに、閉空間内に燃料ガスの流れが発生し、エジェクタ５，燃料電池１０，減圧調整弁３などの圧力損失部に前後差圧を生じることになる。

【００５３】そこで、以下に示す第４の実施形態では、前記前後差圧に基づいて燃料ガス漏れの検知を行う。図７は第４の実施形態の燃料電池システムを示すものであり、減圧調整弁３前後の燃料ガス供給ライン２と燃料ガス供給ライン４との差圧を検出する第１差圧計１６、エジェクタ５前後の燃料ガス循環ライン１２と燃料ガス供給ライン６との差圧を検出する第２差圧計１７、エジェクタ５前後の燃料ガス循環ライン１２と燃料ガス供給ライン６との差圧を検出する第３差圧計１８、燃料電池１０前後の燃料ガス供給ライン６と燃料ガス排出ライン１１との差圧を検出する第４差圧計１９が設けられている。

【００５４】ここで、各差圧計１６～１９（圧力状態検出手段，差圧検出手段）の差圧出力値を、ΔＰ１，ΔＰ２，ΔＰ３，ΔＰ４とし、かつ、各差圧計１６～１９の感圧極性は、図７にプラス記号で示す側の圧力が相対的に高いときに、前記差圧出力値ΔＰ１，ΔＰ２，ΔＰ３，ΔＰ４としてプラスの値が出力されるものとする。そして、前記差圧計１６～１９を用いた燃料ガス漏れの検知は、図８のフローチャートに示す手順で行われる。

【００５５】まず、ステップＳ５１では、出力電流ｉ（電気負荷）が閾値ｉ０よりも小さいか否かを判別する。そして、出力電流ｉ（電気負荷）が閾値ｉ０よりも小さいときには、ステップＳ５２へ進み、パージ弁１３を強制的に閉状態に保持し、次のステップＳ５３では、前記出力電流遮断器３０によって出力電流ｉの出力を遮断し、燃料電池１０の発電（燃料ガスの消費）を止める。

【００５６】ステップＳ５４では、各差圧計１６～１９の出力値ΔＰ１，ΔＰ２，ΔＰ３，ΔＰ４を読み込む。ステップＳ５５では、読み込んだ出力値ΔＰ１，ΔＰ２，ΔＰ３，ΔＰ４が、電気信号ノイズ、又は、燃料電池システムの設計値以内の微小圧力変動値より大きいか否かを、各出力値ΔＰ１，ΔＰ２，ΔＰ３，ΔＰ４の絶対値と予め定めた閾値Ａとを比較して判定する。

【００５７】ここで、全ての出力値ΔＰ１，ΔＰ２，ΔＰ３，ΔＰ４が閾値Ａ以下であるときには、ステップＳ５６へ進み、全ての差圧計１６～１９の検出差圧を０と見なし、次のステップＳ５７では、燃料ガス漏れなしの判定を下す。全ての検出差圧が０の場合は、燃料ガス循環供給ライン４，６，１１，１２における燃料ガスの流れが止まっていることを示し、これは、燃料電池１０の発電を止めたために燃料ガスが消費されないで配管内に留まっている状態と合致することから、燃料ガス漏れは発生していないと判断される。

【００５８】一方、ステップＳ５５で、出力値ΔＰ１，ΔＰ２，ΔＰ３，ΔＰ４の中で閾値Ａを超えるものがあると判断されると、ステップＳ５８へ進む。ステップＳ５８では、差圧計１６～１９の出力値のうちでその絶対値が閾値Ａ以下であるものについては０と見なし、閾値Ａを超えるものについては差圧の方向のみをプラス，マイナスで保存する。

【００５９】そして、ステップＳ５９では、図９に示すような判定マップと、実際の差圧検出パターンとの比較に基づいて、燃料ガス漏れの発生箇所の特定を行う。例えば、第１差圧計１６の検出結果がプラスであるのに対し、第２差圧計１７の検出結果が０又はマイナスであるときには、燃料ガス供給ライン４（Ｑ０配管）において燃料ガスが漏れているものと判定する。

【００６０】即ち、第１差圧計１６の検出結果がプラスであるということは、減圧調整弁３の上流側よりも下流側の圧力が低く、減圧調整弁３において燃料電池１０側に向かう燃料ガスの流れが発生していることになる一方、第２差圧計１７の検出結果が０又はマイナスであるときには、エジェクタ５では流れがないか、燃料ガス供給ライン６側から燃料ガス供給ライン４側に向かう流れが生じていることになり、これは、燃料ガス供給ライン４における燃料ガス漏れの発生を示すことになる。

【００６１】また、第３差圧計１８及び第４差圧計１９の検出差圧が共にマイナスであった場合には、燃料ガス排出ライン１１，燃料ガス循環ライン１２よりも燃料ガス供給ライン６の圧力が低いことになり、これは、燃料ガス排出ライン１１から燃料電池１０を介して燃料ガス供給ライン６側に流れ込む流れが発生し、同時に、燃料ガス循環ライン１２からエジェクタ５を介して燃料ガス供給ライン６側に流れ込む流れが発生していることになり、これは、燃料ガス供給ライン６（Ｑ１配管）における燃料ガス漏れの発生を示すことになる。

【００６２】逆に、第３差圧計１８及び第４差圧計１９の検出差圧が共にプラスであった場合には、燃料ガス供給ライン６よりも燃料ガス排出ライン１１，燃料ガス循環ライン１２の圧力が低いことになり、これは、燃料ガス供給ライン６から燃料電池１０を介して燃料ガス排出ライン１１側に流れ込む流れが発生し、同時に、燃料ガス供給ライン６からエジェクタ５を介して燃料ガス循環ライン１２側に流れ込む流れが発生していることになり、これは、燃料ガス排出ライン１１，燃料ガス循環ライン１２（Ｑ２配管）における燃料ガス漏れの発生を示すことになる。

【００６３】尚、図９中の網掛け表示は、漏れ箇所判定に必要な最小の組み合わせを示し、網掛け部分の組み合わせのみで漏れ箇所を特定することができる。但し、全ての差圧出力から判定することも可能であり、その際には、図９に記載されない条件が検出された場合、燃料電池システム全体が何らかの不具合を起こしていると判断し、緊急停止など重要な警報を出力するようにしても良い。

【００６４】ステップＳ５９で漏れ発生箇所の特定を行うと、ステップＳ６０では、判定結果をその後の修理作業等に備えて履歴情報として記憶し、次のステップＳ６１では、運転者に対しては、漏れ発生を警報または表示にて知らせ、安全確保のための操作を促す。上記のように差圧に基づいて、燃料漏れに伴う燃料ガスの流れの発生を検出する構成であれば、配管内の絶対圧に左右されずに高い検出感度を得ることができ、これによって微少な燃料ガス漏れの検知を行え、またコストも安くできる。

【図面の簡単な説明】

【図１】第１の実施形態における燃料電池システムのブロック図。

【図２】第１の実施形態における漏れ検知の手順を示すフローチャート。

【図３】第２の実施形態における燃料電池システムのブロック図。

【図４】第２の実施形態における漏れ検知の手順を示すフローチャート。

【図５】第３の実施形態における燃料電池システムのブロック図。

【図６】第３の実施形態における漏れ検知の手順を示すフローチャート。

【図７】第４の実施形態における燃料電池システムのブロック図。

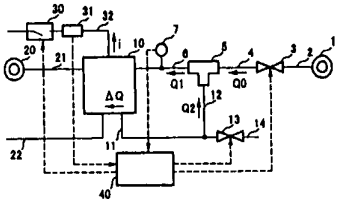
【図８】第４の実施形態における漏れ検知の手順を示すフローチャート。

【図９】第４の実施形態で漏れ箇所判定に用いる判定マップを示す図。

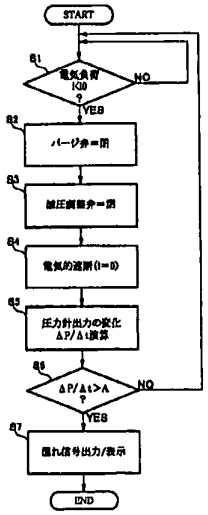
【符号の説明】

１…水素ガス供給源
２…燃料ガス供給ライン
３…減圧調整弁
４…燃料ガス供給ライン
５…エジェクタ
６…燃料ガス供給ライン
７，９…圧力計
８，１５…遮断弁
１０…燃料電池
１１…燃料ガス排出ライン
１２…燃料ガス循環ライン
１３…パージ弁
１４…パージライン
１６～１９…差圧計
２０…酸化剤ガス供給源
２１…ガス供給ライン
２２…排出ライン
３０…出力電流遮断器
３１…電流計
３２…出力配線
４０…信号処理装置

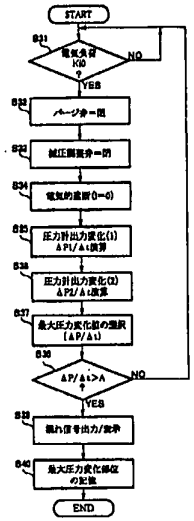
【図１】



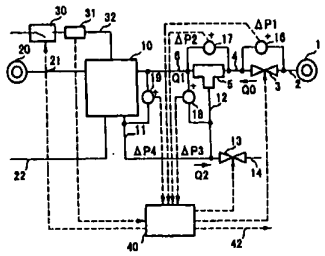
【図２】



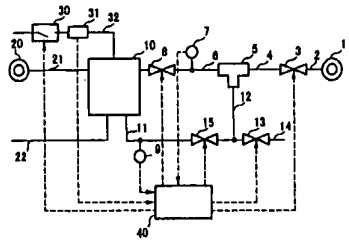
【図６】



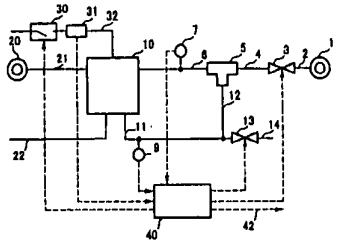
【図７】



【図３】



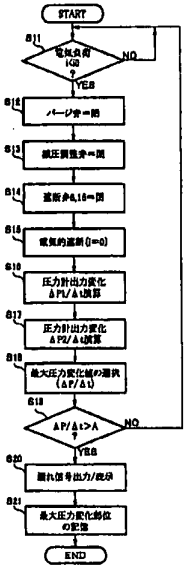
【図５】



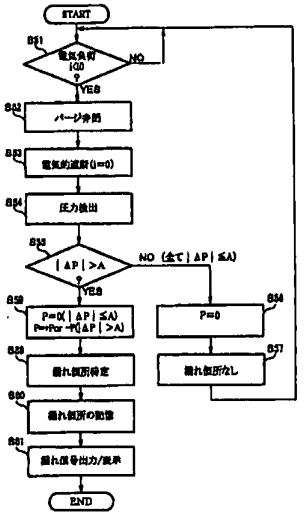
【図９】

	絞圧計出力				漏れ個所
	ΔP1	ΔP2	ΔP3	ΔP4	
1	0	0	0	0	なし
2	+P	0 or −P	0 or −P	0 or −P	Q0配管上
3	0 or +P	+P	−P	−P	Q1配管上
4	0 or +P	+P	+P	+P	Q2配管上

【図４】



【図８】



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(72)発明者 鳥居 修司
神奈川県横浜市神奈川区宝町２番地 日産自動車株式会社内

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